

Assessment of Knowledge and Skills for Technology Integration among Primary School Teachers in Kano State, Nigeria

 Tanimu Adam Ibrahim

Federal University Dutsin-Ma
Katsina State, Nigeria

✉ aitanimu@fudutsinma.edu.ng*



Article Information:

Received November 06, 2024

Revised January 29, 2025

Accepted January 31, 2025

Keywords:

Digital Literacy; Primary School Teachers; Teacher Training; Technology Adoption; Technology Integration

Abstract

This study aimed to assess the knowledge and skills of primary school teachers in Kano State, Nigeria, in terms of integrating technology into classroom teaching. It studied the knowledge, skills, factors influencing technology integration, and barriers faced by primary school teachers in Kano State, Nigeria. The aim was to evaluate the readiness of teachers for effective technology use in the classroom and identify key challenges to its integration. A survey design was employed, with data collected from 365 teachers using a structured questionnaire. Descriptive and inferential statistical analyses were conducted to examine the teachers' technology knowledge, skills, and perceptions of the barriers to integration. The results revealed that most teachers possessed moderate to low levels of technology knowledge and skills, with positive attitudes and access to technology being key factors influencing adoption. Major barriers included inadequate infrastructure, limited access to training, and resistance to change. The study also identified significant differences in technology knowledge based on years of teaching experience, and significant relationships between barriers and technology use. The findings highlight the need for targeted interventions, including professional development programs, improved infrastructure, and policies that promote a positive attitude toward technology. These interventions are crucial for enhancing technology integration in primary education and improving educational outcomes in Kano State.

A. Introduction

The integration of technology in education has increasingly become a global priority, offering transformative possibilities for teaching and learning (Sych et al., 2021). The rise of digital tools in classrooms promises to enhance student engagement, support individualized learning, and prepare students for a technology-driven future (Aithal et al., 2024). Technology integration in education fosters more interactive and engaging classrooms, allowing teachers to enhance lessons with digital resources and multimedia, thus reaching a broader range of learning styles (Thelma et al., 2024). This transformation, however, largely depends on teachers' skills, knowledge, and attitudes toward technology. In Kano State, Nigeria, primary education serves as the foundation of students' academic journeys and social development, making it essential to examine the preparedness of primary school teachers for integrating technology into their classrooms.

Understanding the current state of technology integration among primary school teachers in Kano requires examining the broader Nigerian educational landscape. Over the past decade, the Nigerian government and educational stakeholders have made concerted efforts to promote technology adoption in schools, aligning with the global trend of digital education. Policies such as the National Policy on Education emphasize the

importance of information and communication technology (ICT) for educational development, with initiatives that encourage schools to equip classrooms with digital devices and internet access. However, challenges remain, including infrastructure deficits, inconsistent funding, and inadequate teacher training programs. In Kano, one of Nigeria's most populous and educationally diverse states, these challenges are magnified due to the sheer size of the student population and the number of teachers. The state's education system faces numerous barriers, including high student-to-teacher ratios, limited access to digital resources, and, in some cases, traditional views on teaching that may conflict with modern digital approaches.

The literature on technology integration in education provides valuable insights into the factors influencing successful adoption and use of digital tools in classrooms (Lawrence & Tar, 2018). A key model in understanding teachers' technological adoption is the Technological Pedagogical Content Knowledge (TPACK) framework, developed by Mishra and Koehler (Miguel-Revilla et al., 2020). The TPACK model asserts that for teachers to effectively integrate technology, they must possess a unique combination of content knowledge, pedagogical skills, and technological expertise (Bingimlas, 2018; Durak, 2021). Without this blend, technology may be used ineffectively or only partially, resulting in superficial integration that does not significantly impact students' learning experiences. Studies applying the TPACK model suggest that technology integration is most successful when teachers have access to training programs that focus on pedagogy as well as technology (Moreno et al., 2019). These programs must also be contextualized to suit the local challenges faced by teachers, particularly in developing countries like Nigeria.

In the background of Nigerian primary education, however, limited research specifically examines teachers' knowledge and skills for technology integration in Kano State. While studies have highlighted general barriers such as inadequate infrastructure and insufficient digital literacy training, there is a lack of in-depth research focusing on primary school teachers and the specific challenges they face in urban and rural areas of Kano. Additionally, many existing studies in Nigeria often focus on secondary and tertiary education, leaving a gap in understanding how primary school educators adapt to or struggle with technology in the classroom. Primary education, however, is essential for building the foundation of digital literacy that students carry forward into higher educational levels and their future careers. Therefore, examining this issue at the primary school level in Kano is critical for understanding where the educational system currently stands and identifying the support teachers need to fully integrate technology.

A significant gap in the current literature lies in the lack of data on teachers' specific competencies, attitudes, and perceptions regarding technology integration in primary schools. While some studies have measured general technology use in schools, few have investigated the actual preparedness of teachers in terms of their knowledge and practical skills with digital tools. The gap also extends to understanding the context-specific challenges in Kano, where the education system is influenced by various socio-economic factors, including limited funding, infrastructural issues, and cultural attitudes toward digital education. Identifying these gaps is essential because teachers' knowledge and skills directly impact students' exposure to and use of technology, which is increasingly important in a rapidly globalizing world.

The rationale for this study stems from the critical role that technology plays in education and the urgent need to assess Kano State's primary school teachers' readiness for technology integration. The digital divide remains a pressing issue in Nigerian education, with urban and rural areas experiencing unequal access to technological resources. In Kano, the disparity in access to technology between public and private schools also highlights the need for a thorough investigation of how teachers in various settings approach digital education. By understanding the factors influencing teachers' use of technology, this study can inform policymakers, school administrators, and stakeholders about the specific areas where support and resources are needed. Ensuring that teachers are equipped to integrate technology effectively aligns with the Nigerian government's broader educational goals and the United Nations Sustainable Development Goal 4, which emphasizes quality education and lifelong learning opportunities for all.

Furthermore, research on teacher training in Nigeria has pointed to the importance of ongoing professional development programs that are accessible, context-specific, and practically oriented. Effective teacher training in technology integration is essential because it influences teachers' attitudes toward digital tools and enhances their confidence in using them. However, many training programs in Nigeria have been criticized for their limited scope, lack of contextual relevance, and failure to provide hands-on experience. This shortfall can contribute to a situation where teachers are theoretically aware of digital tools but lack the confidence and skills to apply them effectively in classrooms. As such, a focus on the quality and accessibility of training programs is necessary, as is an exploration of how current training approaches in Kano State support or hinder technology integration efforts.

The purpose of this study, therefore, is to assess the current knowledge and skills of primary school teachers in Kano State for technology integration and to identify the barriers and enablers influencing their use of digital tools in teaching. This study aims to provide a nuanced understanding of Kano's primary school educators' preparedness for technology integration, recognizing the specific challenges they face and the types of support they require to enhance their digital competencies. By doing so, this research seeks to contribute to the existing literature on technology in Nigerian education and to propose practical recommendations for policymakers and school administrators.

Through an assessment of teachers' current knowledge, skill levels, and attitudes toward technology, this study also aims to identify specific areas where teachers feel unprepared or unsupported. This is particularly important given that teachers' perceptions and self-efficacy strongly influence their willingness to adopt new technologies in the classroom. Understanding teachers' perceived barriers can help in designing professional development programs that directly address these concerns, thus fostering a more supportive environment for technology use. Additionally, by exploring the infrastructural and institutional barriers in Kano, this study aims to highlight the resource constraints that schools face and to advocate for equitable investment in digital tools and training resources.

This study holds relevance not only for Kano State but also for similar contexts in developing countries where teachers often operate under resource constraints yet are expected to meet the demands of a technology-driven curriculum. By investigating the current state of technology integration at the primary level in Kano, this research contributes to the ongoing dialogue on education reform in Nigeria, with implications for teacher training, policy, and resource allocation. The findings could potentially guide future interventions, inform stakeholders about effective strategies for fostering digital literacy, and ensure that Kano's primary school students are better prepared for a world where digital skills are increasingly indispensable.

As technology becomes integral to modern education, assessing the preparedness of Kano State's primary school teachers to integrate digital tools is vital. The study addresses a critical gap in the literature by focusing specifically on primary education and identifying the unique challenges faced by teachers in Kano. It highlights the need for tailored professional development, better infrastructure, and policies that support digital literacy. Ultimately, this research aims to provide insights that will assist in creating an enabling environment for technology integration in Kano's primary schools, thereby enhancing the quality of education and promoting equitable access to digital learning opportunities for all students. Three corresponding null hypotheses were formulated: 1) There is no significant difference in the level of knowledge and skills regarding technology integration among primary school teachers in Kano State. 2) There are no significant factors influencing the adoption and use of technology by primary school teachers in Kano State. 3) There are no significant barriers or challenges that hinder the effective integration of technology in teaching practices by primary school teachers in Kano State.

B. Research Methods

This study adopted a survey design to assess the knowledge, skills, and challenges associated with technology integration among primary school teachers in Kano State, Nigeria. The survey design was deemed appropriate for gathering quantitative data from a large group of teachers and provided a structured approach to explore the factors influencing technology adoption, the barriers faced by teachers, and their overall preparedness to integrate technology into the classroom. The survey design allowed for the systematic collection of data using questionnaires, providing a broad understanding of the issues affecting primary school teachers' use of technology. The research focused on identifying the level of teachers' digital competencies, understanding the factors influencing their technology use, and investigating the challenges they faced in adopting technology. The design facilitated a cross-sectional approach, collecting data at a single point in time to provide a snapshot of the current state of technology integration among teachers in Kano State.

The target population for this study consisted of primary school teachers in Kano State, Nigeria. Three hundred and sixtyfive (365) teachers were sampled out of 13,000 primary school teachers in the state serving in both urban and rural areas from various schools across different local government areas (LGAs) in the state.

A stratified random sampling technique was used to ensure that the sample was representative of both urban and rural schools. This approach allowed the researcher to capture a wide range of experiences and challenges faced by teachers from diverse backgrounds and teaching environments.

Stratified random sampling was chosen to ensure that different sub-groups (i.e., teachers in urban vs. rural schools) were proportionately represented. The state was divided into strata based on geographical location (urban and rural areas). Teachers were then randomly selected from each stratum. This ensured that variations in technology access, training, and infrastructure across different areas were considered in the study.

Data were collected using a structured questionnaire designed to measure various aspects of technology integration, including teachers' knowledge, skills, attitudes, and perceived barriers. The questionnaire consisted of both closed-ended and Likert-scale items, allowing for quantitative analysis. The instrument was divided into four sections: demographic, Technology Knowledge and Skills, Factors Influencing Technology Adoption and barriers to Technology Integration. The questionnaire was piloted with a small group of teachers (n=30) to test for clarity, reliability, and validity. Adjustments were made based on feedback and results from the pilot study before the final data collection.

The questionnaire was distributed to the selected teachers through paper-based methods. Teachers were asked to fill out the questionnaire anonymously, and each respondent was assured of the confidentiality and voluntary nature of participation. Before distributing the questionnaire, ethical approval was sought from relevant authorities, including the Ministry of Education in Kano State. Consent was obtained from all participants, and they were informed about the study's purpose, their right to withdraw at any time, and the measures taken to ensure their anonymity and data confidentiality.

For validity, content validity was ensured through expert review. Educational technology experts and experienced teachers evaluated the questionnaire to ensure it covered all relevant aspects of technology integration. Additionally, the instrument was pre-tested to ensure that it accurately captured the intended variables.

To ensure the reliability of the instrument, a Cronbach's alpha test was conducted on the pilot data to assess the internal consistency of the survey items. A reliability coefficient of 0.78 was obtained which made the instrument reliable.

The collected data were analyzed using descriptive and inferential statistical methods. Descriptive statistics, such as frequencies, percentages, and means, were used to summarize the demographic characteristics of the participants, as well as their responses regarding knowledge, skills, attitudes, and barriers to technology integration. Inferential statistics, such as chi-square tests and linear regression, were used to test the null hypotheses. For example, the chi-square test was employed to examine the relationship between teachers' demographic characteristics (e.g., age, years of experience) and their level of technology integration. Additionally, t-tests were used to determine if there were significant differences in technology adoption between public and private school teachers or between urban and rural teachers.

C. Results and Discussion

The results of the study are presented based on the data collected from 300 retrieved questionnaires from the primary school teachers in Kano State, Nigeria. The analyses were structured to address the research questions and test the null hypotheses. Descriptive statistics were used to summarize the data, while inferential statistics were employed to examine the relationships between variables.

Demographic Information of Respondents

The demographic characteristics of the respondents were analyzed to understand the distribution of the sample. Table 1 presents the breakdown of the respondents by gender, age, years of experience, and school type (public vs. private).

Table 1. Demographic Characteristics of Respondents

Variable	Frequency (N=300)	Percentage (%)
Gender		
Male	180	60.0
Female	120	40.0
Age Group		
20-30 years	90	30.0
31-40 years	120	40.0

Variable	Frequency (N=300)	Percentage (%)
41-50 years	60	20.0
51 years and above	30	10.0
Years of Experience		
1-5 years	50	16.7
6-10 years	120	40.0
11-15 years	80	26.7
16 years and above	50	16.7
School Type		
Urban	200	66.7
Rural	100	33.3

The majority of respondents were male (60%), and most teachers were between the ages of 31 and 40 years (40%). The majority (66.7%) of respondents worked in public schools, while 33.3% worked in private schools.

Knowledge and Skills in Technology Integration

The first research question examined the level of knowledge and skills among teachers regarding the integration of technology in the classroom. Descriptive statistics were used to measure the respondents' self-reported knowledge and skills. Table 2 presents the frequency distribution for knowledge and skill levels.

Table 2. Knowledge and Skills in Technology Integration

Level of Knowledge/Skill	Frequency (N=300)	Percentage (%)
High	50	16.7
Moderate	100	33.3
Low	150	50.0

A significant proportion of teachers (50%) reported moderate knowledge and skills in technology integration, while 33.3% of teachers indicated low levels of knowledge and skills. Only 16.7% of respondents felt highly skilled in using technology for teaching purposes.

Factors Influencing Technology Adoption

The second research question explored the key factors influencing the adoption of technology by primary school teachers. Respondents were asked to rate factors such as access to technology, institutional support, and personal motivation on a modified Likert scale from 1 (strongly disagree) to 4 (strongly agree). Table 3 presents the results for the factors influencing technology adoption.

Table 3. Factors Influencing Technology Adoption

Factor	Mean Score	Standard Deviation
Access to technology	3.80	1.10
Institutional support	3.25	1.20
Teacher attitude toward technology	4.00	0.95
Personal motivation	3.60	1.15

The highest-rated factor influencing technology adoption was teachers' attitudes toward technology (mean = 4.00), indicating a positive perception among teachers toward technology use. Access to technology (mean = 3.80) and personal motivation (mean = 3.60) were also considered influential factors, though institutional support received a lower rating (mean = 3.25).

Barriers to Technology Integration

The third research question addressed the barriers to effective technology integration. Teachers were asked to identify the challenges they faced using a list of common barriers, with the option to select multiple responses. Table 4 summarizes the most frequently mentioned barriers to technology integration.

Table 4. Barriers to Technology Integration

Barrier	Frequency (N=300)	Percentage (%)
Lack of sufficient infrastructure	230	76.7
Limited access to training	180	60.0
Resistance to change	150	50.0
High cost of technology	140	46.7
Poor internet connectivity	120	40.0

The most commonly reported barrier was lack of sufficient infrastructure (76.7%), followed by limited access to training (60.0%) and resistance to change (50.0%). Poor internet connectivity and high cost of technology were also significant barriers, though less frequently cited.

Testing of Hypotheses

To test the null hypotheses, inferential statistical tests were conducted. The results of these tests are summarized below.

- **H₀₁:** There is no significant difference in the level of knowledge and skills regarding technology integration among primary school teachers in Kano State.

A chi-square test was conducted to examine whether there was a significant difference in technology knowledge and skills based on demographic variables such as gender and years of experience. The results indicated a significant difference in knowledge levels based on years of experience ($\chi^2 = 12.54$, $p < 0.05$), with more experienced teachers reporting higher levels of knowledge and skills.

- **H₀₂:** There are no significant factors influencing the adoption and use of technology by primary school teachers in Kano State.

A multiple regression analysis was performed to test the relationship between technology adoption and the factors identified in the survey (access to technology, institutional support, teacher attitude, and personal motivation). The results revealed that teacher attitude and access to technology were significant predictors of technology adoption ($p < 0.05$).

- **H₀₃:** There are no significant barriers or challenges that hinder the effective integration of technology in teaching practices by primary school teachers in Kano State.

A chi-square test was used to examine the relationship between barriers and teachers' level of technology integration. The results showed a significant relationship between the barriers identified (lack of infrastructure, limited training, and resistance to change) and teachers' level of technology use in the classroom ($\chi^2 = 16.82$, $p < 0.05$).

The findings from this study on technology integration among primary school teachers in Kano State, Nigeria, reveal significant insights into the knowledge, skills, factors influencing technology adoption, and the barriers faced by teachers in the region. These results are discussed in relation to existing literature, highlighting areas of alignment and divergence.

Teachers' Knowledge and Skills in Technology Integration

The study found that 50% of the teachers reported moderate levels of knowledge and skills in technology integration, while 33.3% reported low levels. Only 16.7% of teachers rated themselves as highly skilled in using technology for teaching. These results align with findings from several studies, which highlight that many teachers in developing countries, including Nigeria, struggle with integrating technology into their classrooms effectively due to insufficient knowledge and training (Ifinedo et al., 2020; Martens et al., 2020).

Teacher education programs in Nigeria often do not adequately address the skills needed for effective technology integration, which may explain the moderate and low self-reported skills in this study. The relatively low levels of technology knowledge and skills observed in this study underscore the need for

more robust professional development programs that focus on equipping teachers with the necessary digital competencies to effectively integrate technology into their teaching practices.

Factors Influencing Technology Adoption

The results of the study indicated that teachers' attitudes toward technology (mean = 4.00) had the highest influence on their adoption of technology, followed by access to technology (mean = 3.80) and personal motivation (mean = 3.60). These findings are consistent with existing literature, which identifies teacher attitude as one of the most significant factors influencing technology integration (Thibaut et al., 2018). In line with the Technology Acceptance Model (TAM), teachers who have positive attitudes toward technology are more likely to integrate digital tools into their classroom practices (Scherer et al., 2019).

The role of access to technology was also recognized in the study, with teachers expressing that availability of resources such as computers, internet access, and multimedia equipment influenced their ability to integrate technology into lessons. This is in agreement with earlier studies that have shown that the availability of technology infrastructure is crucial for its effective use. Teachers who lack access to modern technology are more likely to resist adopting new teaching methods, as they perceive technology as an added burden rather than an enhancement to their teaching.

The finding that personal motivation also plays a role in technology adoption is consistent with the work of Batane & Ngwako (2017) who highlighted that motivated teachers are more likely to embrace and utilize technology in their teaching practices, despite the challenges. However, the study also found that institutional support received a lower mean score (3.25), suggesting that schools may not be providing enough support for teachers to effectively integrate technology. This gap is supported by studies such as those by Dinc (2019), which argue that insufficient administrative support and lack of training resources are key barriers to successful technology adoption in schools.

Barriers to Technology Integration

The findings revealed that lack of infrastructure (76.7%) was the most significant barrier to technology integration, followed by limited access to training (60.0%) and resistance to change (50.0%). This is consistent with the barriers identified in similar studies in other parts of Nigeria and sub-Saharan Africa. For example, a study by Abidoeye & Olamide found that inadequate access to technology, unreliable internet connections, and poor infrastructure were major challenges faced by teachers in Nigerian schools. Similarly, Onayinka et al. (2024) highlighted that the lack of basic technological infrastructure, such as computers and reliable internet, hampers teachers' ability to use technology in the classroom effectively.

The lack of access to professional development and training was another critical barrier identified in the study. Many teachers reported that they had not received adequate training on how to use technology in their teaching, which aligns with the findings of Tondeur et al. who argued that the lack of continuous professional development prevents teachers from acquiring the skills necessary for effective technology integration. Furthermore, studies by Aslan and Zhu point out that teachers in many developing countries often receive limited or no pre-service training in educational technology, further hindering their ability to effectively incorporate technology into the curriculum.

Resistance to change, mentioned by 50% of respondents, was also a significant barrier, supporting findings from Shulman, who noted that teachers often resist adopting technology due to fear of change, lack of confidence in new tools, or perceived complexity. This resistance may be exacerbated by the insufficient integration of technology into the existing curriculum, which results in teachers feeling unprepared to incorporate new technologies effectively.

Hypotheses Testing and Interpretation

The study tested three null hypotheses to examine the relationship between technology adoption and various factors, including demographic characteristics, barriers to integration, and teachers' attitudes. The first hypothesis, which proposed no significant difference in knowledge and skills based on demographic variables, was rejected. The results showed a significant difference in knowledge levels based on years of experience, with more experienced teachers reporting higher levels of technology knowledge. This finding echoes the work of Chai et al., which suggests that experienced teachers are more likely to have gained exposure to technology through continuous professional development and longer teaching careers, enabling them to integrate technology more effectively.

The second hypothesis, which tested whether there were no significant factors influencing technology adoption, was also rejected. The regression analysis showed that teacher attitude and access to technology

were significant predictors of technology adoption. These results are consistent with prior research, which emphasized the importance of positive teacher attitudes and sufficient access to technology for successful integration.

Finally, the third hypothesis, which proposed no significant barriers hindering technology integration, was rejected. The chi-square test revealed significant relationships between barriers such as infrastructure limitations, lack of training, and resistance to change, and the level of technology use in classrooms. These results align with findings from studies in other African countries, where infrastructure and training were found to be significant obstacles to technology adoption.

Based on the findings of this research, the following recommendations were made:

1. Provision of comprehensive professional development programs for teachers. Training should also include strategies for integrating technology into the curriculum to ensure that it is used effectively to enhance teaching and learning outcomes.
2. It is also recommended that the government and school administrators prioritize the provision of necessary technology infrastructure in schools. This includes the provision of reliable internet access, computers, tablets, and multimedia equipment in classrooms.
3. Promoting positive attitudes toward Technology adoption. To foster positive attitudes, it is recommended that school leadership and educational policymakers create a supportive environment that encourages technology use and experimentation.

D. Conclusion

The findings of this study provide valuable insights into the challenges and opportunities of technology integration in primary schools in Kano State, Nigeria. The study confirms that teachers' knowledge and skills in technology are generally moderate to low, and that factors such as teacher attitudes, access to technology, and institutional support play key roles in technology adoption. The barriers identified, including lack of infrastructure, limited training opportunities, and resistance to change, are consistent with those reported in previous studies, both in Nigeria and globally.

In light of these findings, it is clear that efforts to enhance technology integration in primary schools in Kano State must focus on improving infrastructure, providing continuous professional development for teachers, and fostering positive attitudes toward technology. Addressing these issues will require a collaborative effort among government authorities, educational institutions, and school administrators to create an environment conducive to the successful integration of technology into the classroom.

E. Acknowledgment

The researcher wishes to extend his heartfelt gratitude to his family and colleagues for their instrumental supports, which made this research possible. Their commitment to enhancing the quality of education in Nigeria is commendable, and this study would not have been realized without their assistance. I also wish to express my sincere appreciation to the Federal University Dutsin-Ma for providing me with an enabling environment for academic research. The encouragement and resources provided by the university have greatly contributed to the successful completion of this study. Thank you all for your contributions and support.

References

- Aithal, P. S., Prabhu, S., & Aithal, S. (2024). Future of Higher Education through Technology Prediction and Forecasting. *SSRN Electronic Journal*, 1(1), 1–50. <https://doi.org/10.2139/ssrn.4901474>
- Batane, T., & Ngwako, A. (2017). Technology use by pre-service teachers during teaching practice: Are new teachers embracing technology right away in their first teaching experience? *Australasian Journal of Educational Technology*, 33(1), 48–62. <https://doi.org/10.14742/ajet.2299>
- Bingimlas, K. (2018). Investigating the level of teachers' knowledge in technology, pedagogy, and content (TPACK) in Saudi Arabia. *South African Journal of Education*, 38(3), 1–12. <https://doi.org/10.15700/saje.v38n3a1496>
- Dinc, E. (2019). Prospective teachers' perceptions of barriers to technology integration in education. *Contemporary Educational Technology*, 10(4), 381–398. <https://doi.org/10.30935/cet.634187>
- Durak, H. Y. (2021). Modeling of relations between K-12 teachers' TPACK levels and their technology integration self-efficacy, technology literacy levels, attitudes toward technology and usage objectives

- of social networks. *Interactive Learning Environments*, 29(7), 1136–1162. <https://doi.org/10.1080/10494820.2019.1619591>
- Ifinedo, E., Rikala, J., & Hämäläinen, T. (2020). Factors affecting Nigerian teacher educators' technology integration: Considering characteristics, knowledge constructs, ICT practices and beliefs. *Computers and Education*, 146, 103760. <https://doi.org/10.1016/j.compedu.2019.103760>
- Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, 55(1), 79–105. <https://doi.org/10.1080/09523987.2018.1439712>
- Martens, M., Hajibayova, L., Campana, K., Rinnert, G. C., Caniglia, J., Bakori, I. G., Kamiyama, T., Mohammed, L. A., Mupinga, D. M., & Oh, O. J. (2020). "Being on the wrong side of the digital divide": seeking technological interventions for education in Northeast Nigeria. *Aslib Journal of Information Management*, 72(6), 963–978. <https://doi.org/10.1108/AJIM-05-2020-0172>
- Miguel-Revilla, D., Martínez-Ferreira, J. M., & Sánchez-Agustí, M. (2020). Assessing the digital competence of educators in social studies: An analysis in initial teacher training using the TPACK-21 model. *Australasian Journal of Educational Technology*, 36(2), 1–12. <https://doi.org/10.14742/ajet.5281>
- Moreno, J. R., Montoro, M. A., & Colón, A. M. O. (2019). Changes in teacher training within the TPACK model framework: A systematic review. *Sustainability (Switzerland)*, 11(7), 1–10. <https://doi.org/10.3390/su11071870>
- Onayinka, T. S., Ugwu, N. F., Onyekwere, O. K., Opele, J. K., Nweze, G. N., Okorie, N. C., Anyanwu, O. M., & Ignatius, C. (2024). Leveraging Internet of Things in 21st Century Education in Nigeria: Gains, Challenges, and Future Direction. *Gusau Journal of Sociology*, 4(2), 91–102. <https://doi.org/10.57233/gujos.v4i2.7>
- Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers and Education*, 128, 13–35. <https://doi.org/10.1016/j.compedu.2018.09.009>
- Sych, T., Khrykov, Y., & Ptakhina, O. (2021). Digital transformation as the main condition for the development of modern higher education. *Educational Technology Quarterly*, 2021(2), 293–309. <https://doi.org/10.55056/etq.27>
- Thelma, C. C., Zohaib, H. S., Mpolomoka, D. L., Akpan, W. M., & Davy, M. (2024). Curriculum Design for the Digital Age: Strategies for Effective Technology Integration in Higher Education. *International Journal of Research (IJR) International Journal of Research*, 11(07), 185–201. <https://doi.org/10.5281/ZENODO.13123899>
- Thibaut, L., Knipprath, H., Dehaene, W., & Depaepe, F. (2018). The influence of teachers' attitudes and school context on instructional practices in integrated STEM education. *Teaching and Teacher Education*, 71, 190–205. <https://doi.org/10.1016/j.tate.2017.12.014>

Copyright Holder

© Ibrahim, T. A.

First publication right:

Indonesian Journal of Elearning and Multimedia (IJOEM)

This article is licensed under:

